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PARASITES IN SUMMER-CAUGHT PACIFIC ROCKFISHES

by

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ABSTRACT

This investigation was carried out in the summer of 1958 on rockfishes caught in the area extending from Hecate Strait to Cape Blanco, Oregon. The purpose of the investigation was to study (1) the relationship between the area of catch and the degree to which these fish are infested with parasites, (2) the distribution of the parasites in the fillets of the fish, and (3) the method of detecting the parasites and of removing them from the fillets.

Parasites in the fillets of rockfishes are not harmful to man but they present an aesthetic problem. Little information has been published concerning the incidence and distribution of parasites in these fish or on the feasibility of removing the parasites from the infested fish muscle. Accordingly, an investigation was undertaken to study the degree of infestation in relationship to the area in which the fish are caught, the distribution of the parasites in the fillets, and the problem of detecting and removing the parasites.

SPECIES OF ROCKFISH STUDIED

Most of the information obtained concerned Pacific ocean perch (*Sebastodes alutus*), since this was the principal species of rockfish being landed at the time of the survey (July and August 1958). Furthermore, a common practice in the industry is to distinguish only Pacific ocean perch from the various species of Scorpaenidae landed. Other species usually are loosely grouped as snapper, red rockfish, and black rockfish. The results of this survey therefore are reported primarily in relation *S. alutus,* though some information is included concerning other individual species.

SPECIES OF PARASITES STUDIED

The most common muscle parasite of *S. alutus* has been reported to be a trematode, *Prosorhynchus* sp. The larval stage of this parasite occurs as cysts in the muscle tissue of the fish and may be observed as whitish to black spots, 2 to 5 millimeters in length. *Prosorhynchus* gains entry to the muscle in the wormlike cercarial stage by boring under the scales and into the tissues, where it encysts. There is no evidence that this trematode can infest man. The objection to its presence in fish marketed for human consumption is based on aesthetic grounds.

The larva of the trematode *Porracaecum decipiens,* known as the cod-worm, is reported to occur in Pacific ocean perch and other rockfish. In this case also the fish is an intermediate host. The larvae, which occur in the muscle of the fish, are wormlike, white to reddish brown in color, and 5 millimeters to 9 centimeters in length. They gain access to the tissues from the alimentary canal. These parasites are particularly objectionable aesthetically, since after the fish fillet has been cut, the parasites tend to migrate from the interior of the fillet and appear between the plastic or cellophane wrap-

[1]Contribution No. 47, College of Fisheries, University of Washington, Seattle, Washington.

ping and the fillet surface. They are not known to infest man.

An unidentified parasitic copepod also was encountered in this investigation. The two species mentioned above, however, present the greatest problem to the industry.

FISHING AREAS STUDIED

As a result of generous cooperation by the industry, access was obtained to processing plants in Seattle, Bellingham, and the Astoria area. Much useful information was obtained.

At each plant, the fishermen who had landed the fish being examined were asked when and where the fish had been caught. They also were questioned generally about the rockfish industry and the problem of parasites in this group. From the information obtained, it appeared that the Oregon-Washington-British Columbia fishery (figure 1) could be divided into three areas: northern, middle, and southern. Drawing dividing lines through regions of little or no fishing activity, one can define these areas as follows:

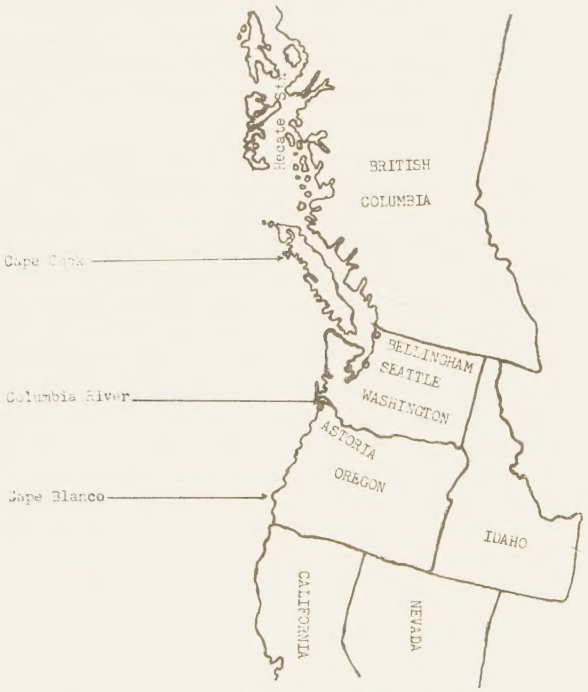

Figure 1.--Oregon-Washington-British Columbia fishery.

Northern - Hecate Strait to Cape Cook.

Middle - Cape Cook to Columbia River (includes rich banks of La Perouse, Flattery Spit, and Destruction Island).

Southern - Columbia River to Cape Blanco (includes most of the Oregon fishery).

Northern Area: Hecate Strait is a highly productive fishing area. An average otter-trawl tow of 1 hour (maximum 2 hours) usually will net 2,000 to 5,000 pounds of fish. In fact, as much as 20,000 pounds of fish has been caught during a 1-hour tow. In this area, Pacific ocean perch usually are caught in 100 to 140 fathoms, whereas other rockfish usually are caught in 60 to 80 fathoms. The species *S. rubrivinctus*, *S. pinniger*, and *S. brevispinis* often are mixed in, however, with catches of *S. alutus*.

Middle Area: Several rich fishing grounds are in the middle area. Usually, 60,000 pounds of rockfish can be obtained in 4 or 5 days of fishing. These fish are less abundant than in the northern area. The average length of tow for a 2,000- to 5,000-pound catch is 2 hours. The grounds are popular because they are near the major fishing ports of Washington and Oregon, and the rockfish are reputed to be less heavily parasitized than are those taken farther north. In general, rockfish are abundant all along the inshore waters of Washington. The species *S. pinniger* is reported to be plentiful off the west coast of Vancouver Island in the spring.

Southern Area: The population of Pacific ocean perch seems to be rather scattered in this area. The average length of tow is about 4 hours. The yield is about 2,000 pounds of fish per tow.

EXAMINATION PROCEDURE

Permission was obtained to work in a plant on a day when rockfish were being filleted. Fillets for examination were selected at random, by the investigator, from the end of the filleting line.

In all plants the workers were informed of the purpose of the investigation in order to enlist their cooperation. To determine the distribution of parasites in the fish, the fillets were arbitrarily divided by imaginary lines into six areas, as is shown in figure 2. Each fillet selected was examined by reflected light, and the total number of parasites observed was recorded. The fillet then was examined on a candling table, and the location and number of parasites seen by this method were noted.

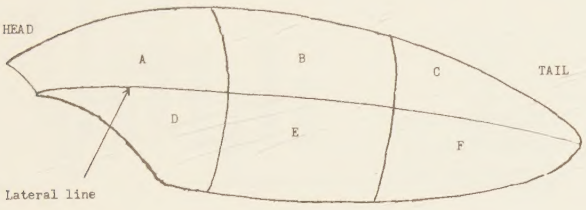

Figure 2.--Division of the fillet into arbitrarily areas for parasite count.

RESULTS

Northern Area

Fish taken from the northern area were examined at Bellingham. A sample of 805 fillets from 76,500 pounds of *S. alutus* were inspected. The data obtained are shown in table 1 and figure 3.

A few fillets of *S. melanops* from the area also were examined and were found to be parasitized by *Prosorhynchus*. This species is reputed to be so heavily parasitized that plant operators refuse to buy it except for mink food.

Four thousand pounds of *S. pinniger* was landed by one boat, and 200 fillets from this batch were examined. No parasites of any kind were observed.

In addition to *Prosorhynchus* and *Porracaecum*, a parasitic copepod was observed in Pacific ocean perch fillets from fish taken in the northern area. This parasite lies in the flesh encased in a sac containing dark-colored fluid (actually waste material) under pressure. If the sac is ruptured during filleting, the liquid spurts forth, sometimes as far as several feet. Fish showing signs of this parasite normally are discarded, and though the incidence of the copepod is small (about 0.01 percent), it is a source of annoyance and concern to the filleters. (The parasite also was observed in Pacific ocean perch from the southern area.)

Middle Area

Pacific ocean perch from the middle area were examined at Seattle. A

Table 1 -- Parasitic infestation of Pacific ocean rockfish

Fishing Ground	Species	Fillets Examined	Fillets parasitized	Incidence of parasitization
				Percent
Northern	S. alutus	805	316	39
Middle	S. alutus	414	88	21
Southern	S. alutus	375	56	15
Middle	Rockfish misc.	83	34	41
	S. pinniger	108	8	7

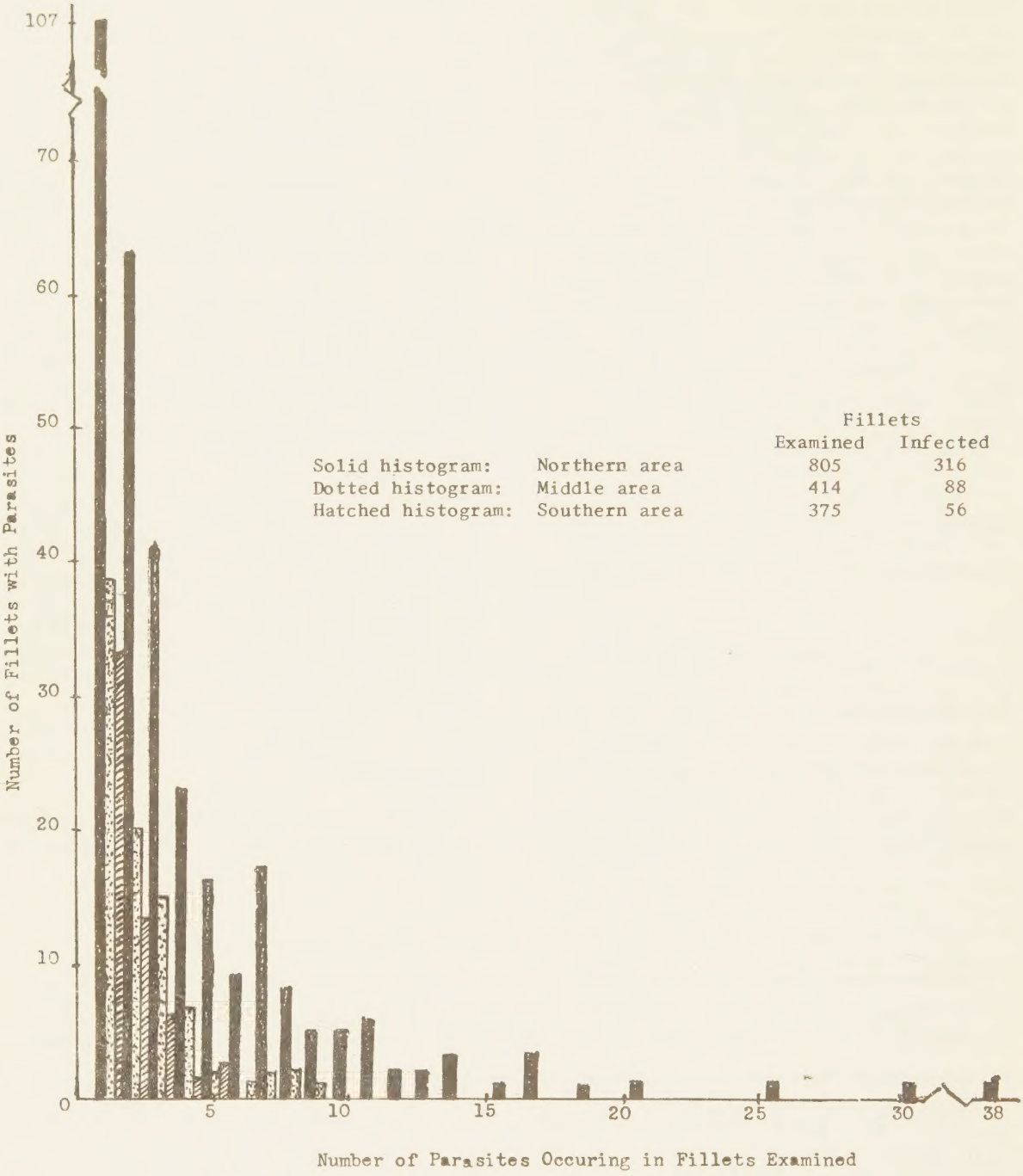

Figure 3.--Frequency distribution of parasites in *Sebastodes alutus*.

sample of 414 fillets from 20,000 pounds of perch was inspected. The data obtained are shown in table 1 and figure 3.

A mixed catch of rockfish (excluding *S. alutus*) landed at Bellingham was inspected. The catch consisted of 7,000 pounds, from which 83 fillets were examined. The data obtained are shown in table 1 and figure 4.

A catch of *S. pinniger* landed at Astoria but caught in the middle region also was examined. A sample of 108 fillets from the landing of 6,000 pounds was inspected. The data obtained are shown in table 1. Seven of the eight parasitized fillets found contained only one parasite, while the remaining fillet contained two.

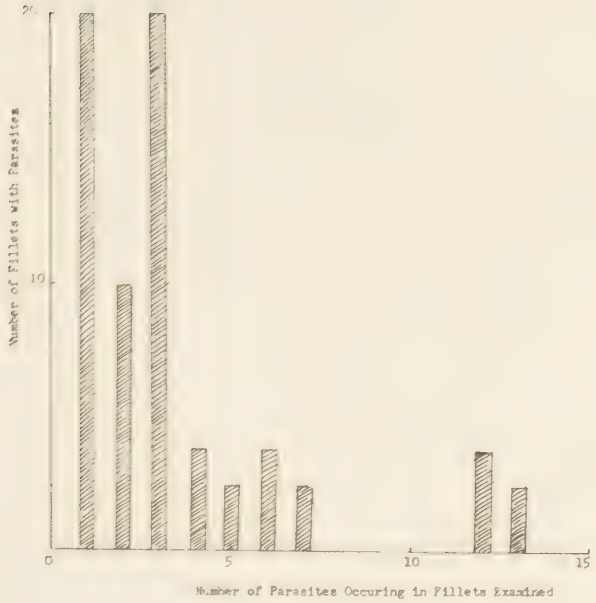

Figure 4.--Frequency distribution of parasites in misc. rockfish (excluding *S. alutus*) from middle area.

Southern Area

Fish taken in three trips, all landed in the Astoria area, were sampled. From 60,000 pounds of Pacific ocean perch landed, 375 fillets were examined. The data obtained are shown in table 1 and figure 3.

No other species from this area were available for examination. The general opinion was, however, that *S. melanops* usually is infested heavily. This fish was also held in disfavor because of its allegedly poor holding characteristics.

The troublesome parasitic copepods observed in Pacific ocean perch from the northern area were encountered also in fish from the southern area. According to filleters questioned about this parasite, it only occasionally appears in numbers in fish on the line. This sporadic appearance might indicate either a cyclic periodicity in occurrence or localization in certain grounds fished only occasionally. Insufficient information is available to say which, if either, of these explanations is correct.

An odd condition that might be mistaken for parasitization was encountered in some of the Pacific ocean perch from the southern area. It took the form of so-called "blemishes," resembling a kernel of unpolished rice in size and appearance and occurring in the muscle. These blemishes have been examined by Mr. J. Uzmann of the United States Fish and Wildlife Service and have tentatively been identified as aberrant cartilaginous tissue. They have caused trouble with purchases made under Federal specifications in the past, but now are officially recognized by the purchasing authorities as "harmless and edible."

DISCUSSION

Geographic Distribution

The incidence of parasitization of perch was high in the northern area. In this survey, 39 percent of the Pacific ocean perch were infested, but reliable informants assert that in many landings, the percentage infested is even higher, up to 90 percent of the catch.

It is interesting to note that even within the Northern area the extent of parasite infestation seemed to vary. Thus the most northerly catch examined, from Hecate Strait, showed an average of nearly seven parasites per infested fillet (table 5). Nevertheless, the percentage of fish parasitized was similar in this sample and in other samples from the Northern area (see table 6 and discussion below). More than 50 percent of the infested fish contained only one or two parasites per fillet (table 3), but more than 20 percent contained more than five per fillet. The part of the fillet most commonly parasitized was the tail portion, but there was a high incidence of parasites in the thick, meaty "shoulder" portion of the fillet (area A, table 2).

The incidence of parasitism in ocean perch caught in the middle area was about one-half that observed in the northern area, though it was still high. Two-thirds of the infested fillets contained only two or fewer parasites per fillet. Less than 10 percent showed more than five parasites per fillet, and none showed more than nine per

Table 2 -- Average number of parasites in designated area of parasitized fillet

Fishing Ground	Species	Average number of parasites in designated area*					
		A	B	C	D	E	F
Northern	S. alutus	0.797	0.671	0.918	0.190	0.560	0.763
Middle	S. alutus	0.841	0.261	0.705	0.057	0.239	0.193
Southern	S. alutus	0.268	0.321	0.464	0.125	0.179	0.375
Middle	Rockfish misc.	0.441	0.441	0.529	0.500	0.941	0.588
	S. pinniger	0.500	0.375	0.000	0.000	0.000	0.250

* For delineation of area, see Figure 1.

Table 3 -- Incidence of parasitization in Pacific ocean perch and incidence of two or fewer parasites among the parasitized fish

Fishing Ground	Incidence of parasitization in all of the fish	Incidence of two or fewer parasites in the parasitized fish
	Percent	Percent
Northern	39	54
Middle	21	67
Southern	15	82

fillet (as compared with more than 30 per fillet in fish from the northern area). In these fish, most of the parasites occurred in the meaty "shoulder" portion of the fillet, but the tail portion also was commonly parasitized.

The incidence of parasitization in miscellaneous rockfish from the middle area was as high as that in Pacific ocean perch from the northern area (approximately 40 percent). This observation is in accordance with the belief in the industry that other rockfish are more generally parasitized than are Pacific ocean perch. Less than half the parasitized fillets showed one or two parasites per fillet, but nearly three-quarters had three or less. The highest infestation observed was 13 parasites per fillet. The tail portion of the fillet was most intensively parasitized, but parasites occurred generally throughout the fillet.

The incidence of parasites in *S. pinniger* from the middle area, however, was very low. This observation accords well with the finding for fish of this species caught in northern waters. All infested fillets had one or two parasites per fillet. In the few fish that were infested, the parasites occurred mainly in the anterior dorsal region of the

fillet, with a few occurring near the tail portion and none occurring in the middle portions.

The observed incidence of parasites in Pacific ocean perch from the southern area (15 percent) was lower than that in fish from either the northern or the middle area. Over 80 percent of the infested fish had two or fewer parasites per fillet, and the most heavily parasitized fillet observed contained only six parasites. Again, fillets were parasitized most commonly in the tail portion.

Though, in this preliminary survey, too few samples were taken for a detailed statistical analysis that would yield truly definitive results, a simple analysis of some of the individual catch data listed in table 5 does illustrate certain interesting points. The results of the analysis are shown in table 6. The standard deviations were calculated, using a mean weighted in each case according to the population of fish sampled (i.e. the hailed catch), on the assumption that the samples were sufficiently random to be representative. Obviously, the northern area fish show a consistently high level of parasite infestation with little variation; the calculated range at 95 percent confidence is only 33.48 to 43.0 percent. The wide range indicated for middle area fish might be evidence of an intermingling of more and less heavily parasitized stocks of Pacific ocean perch in this area. It could be concluded similarly that there is an intermingling of stocks of this type in the southern area also, but the low value of the weighted mean for this area probably indicates a preponderance of lightly parasitized fish.

The high incidence of parasites in Pacific ocean perch from the northern area is well recognized in the industry and is believed to be related to the large size of the fish population in the region, which in turn is believed to be related to the total amount of fishing, past and present, that has taken place there. The fishing intensity probably has been less, over the years, in the northern area than in the more southerly grounds. Nevertheless, the area continues to be fished, since the abundance of the catch compensates, no doubt, for the losses due to parasites.

The fish buyers in Astoria are aware of the low parasitization of Pacific ocean perch caught in the southern area.

Table 4 -- Examination of fillets with and without candling

Fishing Ground	Species	Fillets found infected with candling	Fillets found infected without candling	Effectiveness of inspection without candling
				Percent
Northern	S. alutus	1214	557	45
Middle	S. alutus	202	121	60
	Misc. rockfish	107	38	36
	S. pinniger	9	4	44
Southern	S. alutus	97	55	57
Total		1629	775	48

Table 5 -- The incidence of parasitized fillets in individual boat-loads of Pacific ocean perch

Fishing Area	Hailed catch	No. fillets examined	No. fillets with parasites	Percent parasitized	Total No. parasites	Mean No. parasites/fish
	Pounds			Percent		
Northern						
1) Cape Scott	2,000	78	32	41.0	79	2.5
2) Cape Scott	9,500	267	110	41.2	290	2.6
3) Cape Scott	30,000	310	118	38.1	470	4.0
4) Southern Hecate Strait	35,000	150	56	37.4	375	6.7
Middle						
1) Cape Flattery	6,000	271	46	17.0	106	2.3
2) Cape Flattery	8,000	97	27	27.9	63	2.3
3) Destruction Island	6,000	46	15	32.6	33	2.2
Southern						
1) North Oregon Coast	20,000	140	31	22.1	62	2.0
2) North Oregon Coast	25,000	110	5	4.5	7	1.4
3) North Oregon Coast	15,000	125	20	16.0	28	1.4

Table 6 -- Statistical analysis of percentage infestation data

Fishing area	Mean percent fish parasitized*	Standard deviation	Upper limit of parasitization**	Lower limit of parasitization**
	Percent	Percent	Percent	Percent
Northern	38.24	2.38	43.00	33.48
Middle	24.66	8.13	40.92	8.40
Southern	13.24	9.02	31.28	0.00

* Mean = weighted according to total hailed catch.
** Established at 95 percent confidence level; that is, ± 2 x S.D.

In view of the importance of parasitization in relation to Federal purchases, the industry tries to ensure that all Pacific ocean perch landed in the area are equally free from parasites. The buyers often refuse to purchase fish caught in the heavily parasitized Hecate Strait area.

Table 3 summarizes the results for the three areas and shows clearly that both the incidence and the degree of parasitization decrease from north to south. It should be remembered, however, that this investigation was conducted only during the summer. Further investigations are necessary to establish whether seasonal factors may influence the geographical distribution.

Two theories are available to account for the observations. According to one theory, the extent of parasitization is dependent primarily upon the size of the host-fish population. When large populations exist, many hosts are available, and parasitization is high. As was indicated above, this theory is in accord with what is known about the abundance of Pacific ocean perch in the three areas considered. If the theory is correct, then intensive, controlled fishing of the northern areas would seem to be the only practical method of reducing parasitization.

The second theory is dependent on the fact that a *Prosorhynchus* sp. is the principal parasite infesting Pacific ocean perch and suggests that there is a geographic limit on this parasite or on one of its hosts other than Pacific ocean perch, which amounts to the same thing. Again, this theory seems to be equally possible.

The economic importance of the problem would indicate the advisability of a study to determine which, if either, of these two theories is correct.

Distribution of Parasites in the Fillets

The distribution of the parasites in the fillets is shown in table 2. If only *S. alutus,* which is the species given the most study, is considered, the areas showing the greatest infestation ranged in the order C, A, F, B, E, D, with area C showing the most infestation and area D, the least. Thus the greatest amount of infestation was in the tail and the shoulder portions of the fillets.

It is fortunate that most parasites occur in the tail portion, since the musculature is thin in the tail of the fish, and the whole area can be cut off the fillet without much loss. In some plants, the trimming is more or less automatically done during skinning.

The parasitization of the "shoulder" region is much more difficult to deal with, since this is the most meaty portion of the fish. Individual cutting out of the parasites in this area is

necessary. Where the number of parasites is great, it seems that, balancing the cost of labor to remove the affected portion, plus the loss of weight from the fillet, against the value of the fillet, the best course is to discard the fillet altogether.

Detection and Removal of Parasites

Table 4 summarizes the data derived from examining fillets for parasites with and without candling. The advantage of using a candling table is obvious from these results.

No effective substitute for hand trimming of the parasites has been devised as yet.

SUMMARY

The parasites *Prosorhynchus* sp., *Porracaecum decipiens*, and an unidentified copepod cause considerable economic loss in the Pacific rockfish industry. These parasites are not harmful to man, but their presence in rockfish fillets is aesthetically objectionable.

In a study made during the summer of 1958 on rockfish taken in the area from Hecate Strait to Cape Blanco, Oregon, it was found that the incidence of parasitization for *Sebastodes alutus* ranged from the northern area to the southern area as follows: 39 percent for the northern area, 21 percent for the middle area (Cape Cook to the Columbia River), and 15 percent for the southern area.

Two theories can account for the geographical distribution of the major parasite, *Prosorhynchus*. One relates the abundance inversely with the intensity of fishing. The second suggests that there is a geographical limit on the parasite or on one of its hosts. The economic importance of the problem indicates the advisability of a study to determine which, if either, of the two theories is correct.

Candling was found to be much more effective than unaided visual inspection in the detection of parasites in fillets. Without the aid of candling, the inspector missed half of the parasites present.

Most of the infested fish had one or two parasites. The number of parasites per parasitized fish was greater in fish caught in the northern fishing area than in those caught in the southern area. The parasites tended to be localized in the tail section of the fillet and in the meaty shoulder section. The tail sections can be discarded with little economic loss, but the shoulder section poses more of a problem. No effective substitute for hand trimming to remove the parasites has been devised.

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